

22 DEC 2004

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property
Organization
International Bureau



(43) International Publication Date
22 January 2004 (22.01.2004)

PCT

(10) International Publication Number
WO 2004/008497 A3

- (51) International Patent Classification⁷: **B32B 15/06**, 15/16, 15/20, 25/02, 25/04, 25/20, 31/00, H05K 7/20
- (74) Agent: **THOMPSON, Sandra**; BINGHAM MC-CUTCHEN, LLP, Three Embarcadero Center, San Francisco, CA 94111-4067 (US).
- (21) International Application Number:
PCT/US2003/022710
- (22) International Filing Date: 15 July 2003 (15.07.2003)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
60/396,294 15 July 2002 (15.07.2002) US
- (71) Applicant (for all designated States except US): **HONEYWELL INTERNATIONAL INC.** [US/US]; PO Box 2245, 101 Columbia Road, Morristown, NJ 07962 (US).
- (72) Inventors; and
- (75) Inventors/Applicants (for US only): **DEAN, Nancy** [US/US]; HONEYWELL INTERNATIONAL INC., PO Box 2245, 101 Columbia Road, Morristown, NJ 07962 (US). **KNOLL, Paula** [US/US]; HONEYWELL INTERNATIONAL INC., PO Box 2245, 101 Columbia Road, Morristown, NJ 07962 (US). **TOWNSEND, Robert** [US/US]; HONEYWELL INTERNATIONAL INC., PO Box 2245, 101 Columbia Road, Morristown, NJ 07962 (US). **NGUYEN, MY** [US/US]; HONEYWELL INTERNATIONAL INC., PO Box 2245, 101 Columbia Road, Morristown, NJ 07962 (US). **EDIE, Colin** [US/US]; HONEYWELL INTERNATIONAL INC., PO Box 2245, 101 Columbia Road, Morristown, NJ 07962 (US). **CURRAN, Dan** [US/US]; HONEYWELL INTERNATIONAL INC., PO Box 2245, 101 Columbia Road, Morristown, NJ 07962 (US).
- (81) Designated States (*national*): AE, AG, AL, AM, AT (utility model), AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ (utility model), CZ, DE (utility model), DE, DK (utility model), DK, DM, DZ, EC, EE (utility model), EE, ES, FI (utility model), FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK (utility model), SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.
- (84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).
- Published:**
— with international search report
— with amended claims
- (88) Date of publication of the international search report:
1 April 2004
- Date of publication of the amended claims: 6 May 2004
- For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: THERMAL INTERCONNECT AND INTERFACE SYSTEMS, METHODS OF PRODUCTION AND USES THEREOF

(57) Abstract: Layered thermal components described herein include at least one thermal interface component and at least one heat spreader component coupled to the thermal interface component. A method of forming layered thermal components disclosed herein comprises: a) providing at least one thermal interface component; b) providing at least one heat spreader component; and c) physically coupling the at least one thermal interface component and the at least one heat spreader component. At least one additional layer, including a substrate layer, can be coupled to the layered thermal component. A method for forming the thermal interface components disclosed herein comprises a) providing at least one saturated rubber compound, b) providing at least one amine resin, c) crosslinking the at least one saturated rubber compound and the at least one amine resin to form a crosslinked rubber-resin mixture, d) adding at least one thermally conductive filler to the crosslinked rubber-resin mixture, and e) adding a wetting agent to the crosslinked rubber-resin mixture. This method can also further comprise adding at least one phase change material to the thermal interface component. A suitable interface material can also be produced that comprises at least one solder material. Additionally, a suitable interface material can be produced that comprises at least one solder material and at least one resin component.

WO 2004/008497 A3

AMENDED CLAIMS

received by the International Bureau on 11 March 2004 (11.03.2004)
claims 1-50 replaced by new claims 1-50.

1. A layered thermal component, comprising:

at least one thermal interface component, wherein the thermal interface component comprises at least one rubber compound and at least one thermally conductive filler material; and

at least one heat spreader component coupled to the thermal interface component.
2. The layered thermal component of claim 1, wherein the at least one thermal interface component comprises a crosslinkable material.
3. Canceled.
4. The layered thermal component of claim 2, wherein the at least one thermal interface component further comprises at least one crosslinker moiety, at least one crosslinking compound or at least one crosslinking resin.
5. The layered thermal component of claim 4, wherein the at least one crosslinker moiety, the at least one crosslinking compound or the at least one crosslinking resin comprises an amine resin or an amine-based compound.
6. The layered thermal component of claim 1, wherein the at least one rubber compound comprises at least one terminal hydroxyl group.
7. The layered thermal component of one of claims 1 or 6, wherein the at least one rubber compound comprises at least one secondary, tertiary or otherwise internal hydroxyl group.
8. The layered thermal component of claim 1, wherein the at least one thermal interface component comprises at least one solder material.
9. The layered thermal component of claim 8, wherein the at least one solder material comprises a paste.

10. The layered thermal component of claim 8, wherein the at least one solder material comprises at least one of the following: indium, copper, silver, aluminum, gallium, tin or bismuth.
11. The layered thermal component of claim 8, wherein the at least one thermal interface component further comprises at least one resin component.
12. The layered thermal component of claim 11, wherein the at least one resin component comprises a silicone compound.
13. The layered thermal component of claim 12, wherein the silicone compound comprises a vinyl Q resin or a vinyl silicone.
14. The layered thermal component of claim 11, wherein the at least one solder material comprises at least one of the following: indium, tin, silver, bismuth or aluminum.
15. The layered thermal component of claim 11, further comprising a crosslinking additive.
16. The layered thermal component of claim 15, wherein the crosslinking additive comprises a siloxane compound.
17. The layered thermal component of claim 16, wherein the siloxane compound comprises a hydride functional siloxane compound.
18. The layered thermal component of claim 1, wherein the at least one heat spreader component comprises at least one metal or metal-based base material.
19. The layered thermal component of claim 18, wherein the at least one metal or metal-based base material comprises nickel, aluminum or copper.
20. The layered thermal component of claim 19, wherein the at least one metal or metal-based base material comprises AlSiC.
21. The layered thermal component of claim 1, wherein the at least one heat spreader component has a thickness of about 0.25 mm to about 6 mm.
22. The layered thermal component of claim 21, wherein the at least one heat spreader component has a thickness of about 1 mm to about 5 mm.

23. A method of forming a layered thermal component, comprising:
providing at least one thermal interface component, wherein the thermal interface component comprises at least one rubber compound and at least one thermally conductive filler material;
providing at least one heat spreader component; and
coupling the at least one thermal interface component to the at least one heat spreader component.
24. The method of claim 23, wherein the at least one thermal interface component comprises a crosslinkable material.
25. Canceled.
26. The method of claim 24, wherein the at least one thermal interface component further comprises at least one crosslinker moiety, at least one crosslinking compound or at least one crosslinking resin.
27. The method of claim 26, wherein the at least one crosslinker moiety, the at least one crosslinking compound or the at least one crosslinking resin comprises an amine resin or an amine-based compound.
28. The method of claim 23, wherein the at least one rubber compound comprises at least one terminal hydroxyl group.
29. The method of one of claims 23 or 28, wherein the at least one rubber compound comprises at least one secondary, tertiary or otherwise internal hydroxyl group.
30. The method of claim 23, wherein the at least one thermal interface component comprises at least one solder material.
31. The method of claim 30, wherein the at least one solder material comprises a paste.
32. The method of claim 30, wherein the at least one solder material comprises at least one of the following: indium, copper, silver, aluminum, gallium, tin or bismuth.
33. The method of claim 30, wherein the at least one thermal interface component further comprises at least one resin component.

34. The method of claim 33, wherein the at least one resin component comprises a silicone compound.
35. The method of claim 34, wherein the silicone compound comprises a vinyl Q resin or a vinyl silicone.
36. The method of claim 33, wherein the at least one solder material comprises at least one of the following: indium, tin, silver, bismuth or aluminum.
37. The method of claim 33, further comprising a crosslinking additive.
38. The method of claim 37, wherein the crosslinking additive comprises a siloxane compound.
39. The method of claim 38, wherein the siloxane compound comprises a hydride functional siloxane compound.
40. The method of claim 23, wherein the at least one heat spreader component comprises at least one metal or metal-based base material.
41. The method of claim 40, wherein the at least one metal or metal-based base material comprises nickel, aluminum or copper.
42. The method of claim 41, wherein the at least one metal or metal-based base material comprises AlSiC.
43. The method of claim 23, wherein the at least one heat spreader component has a thickness of about 0.25 mm to about 6 mm.
44. The method of claim 43, wherein the at least one heat spreader component has a thickness of about 1 mm to about 5 mm.
45. An electronic component comprising the layered thermal component of claim 1.
46. A semiconductor component comprising the layered thermal component of claim 1.
47. An electronic component comprising the layered thermal component of claim 23.
48. A semiconductor component comprising the layered thermal component of claim 23.

49. A method for forming the thermal interface component of claim 1 or claim 23, comprising:
- providing at least one saturated rubber compound;
 - providing at least one amine resin;
 - crosslinking the at least one saturated rubber compound and the at least one amine resin to form a crosslinked rubber-resin mixture;
 - adding at least one thermally conductive filler to the crosslinked rubber-resin mixture;
 - and
 - adding a wetting agent to the crosslinked rubber-resin mixture.
50. The method of claim 49, further comprising adding at least one phase change material to the thermal interface material.

10 Feb 2004

22 DEC 2004

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US03/22710

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : B32B 15/06, 15/16, 15/20, 25/02, 25/04, 25/20, 31/00; H05K 7/20

US CL : 361/704, 717, 719; 428/332, 411.1, 447, 457, 500

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 361/704, 717, 719; 428/332, 411.1, 447, 457, 500

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

DERWENT

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X — Y	US 4,450,471 A (WELLHOEFER et al.) 22 May 1984 (22.05.1984), column 1, line 33-column 2, line 47 and column 3, lines 15-42.	1, 2, 8-11, 14, 15, 18, 19, 23, 24, 30-33, 37, 40, 41, 45-48 20-22, 42-44
X — Y	US 5,440,230 A (HEFLINGER) 8 August 1995 (08.08.1995), column 4, line 61-column 5, line 10 and Figure 2A.	1, 2, 23, 24, 45-48 3, 4, 18-22, 25, 26, 40-44
X — Y	US 5,847,929 A (BERNIER et al.) 8 December 1998 (08.12.1998), column 10, lines 18-22, and column 11, lines 1-40.	1, 2, 18, 19, 23, 24, 40, 41, 45-48 3-7, 20-22, 25-29, 42-44, 49



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier application or patent published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

"T"

later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X"

document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y"

document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&"

document member of the same patent family

Date of the actual completion of the international search

11 December 2003 (11.12.2003)

Date of mailing of the international search report

21 JAN 2004

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

Facsimile No. (703)305-3230

Authorized officer

Ramsey Zacharia

Telephone No. (703) 308-0661